

इंटरनेट

मानक



Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”

Mazdoor Kisan Shakti Sangathan

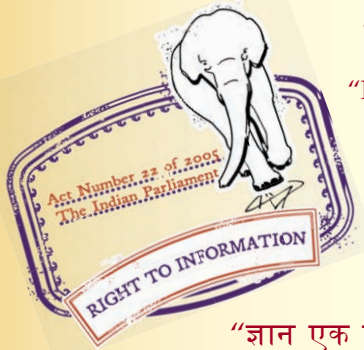
“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 12965 (1990): Glossary of Terms Used in Electromagnetic (Eddy Current) Testing [MTD 21: Non-Destructive Testing]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE



Indian Standard

**GLOSSARY OF TERMS
USED IN ELECTROMAGNETIC
(EDDY CURRENT) TESTING**

UDC 621.954.63.015.25

© BIS 1990

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards on 23 March 1990, after the draft finalized by the Non-destructive Testing Sectional Committee had been approved by the Metallurgical Engineering Division Council.

Electromagnetic (Eddy current) testing has been evolved as a useful tool specially for tubular products. In this method the tube is passed through or in proximity of coil energized with alternating current at one or more frequencies. During passage of the tube the change in electromagnetic response caused by the metallurgical and magnetic discontinuities in tubes produce electrical signal in coil which are amplified and modified to actuate an indicating mechanism.

In view of the fact that various terms are used in this testing, it has been felt necessary to define and unify the different terminologies used in this field, to avoid any confusion arising out of the use of different terms for the same concept or the same term for different concept.

Indian Standard

GLOSSARY OF TERMS USED IN ELECTROMAGNETIC (EDDY CURRENT) TESTING

1 SCOPE

1.1 This standard defines the terms commonly used in the field of electromagnetic (eddy current) testing/inspection.

2 TERMINOLOGY

2.1 Absolute Coil

Coils (or coil) that respond(s) to the electromagnetic properties of that region of the test part, that is, within the magnetic field of the coil, without comparison to the response of a second coil at a different location on the same or similar part.

2.2 Absolute Measurements

Measurements made with an absolute coil, in contrast to differential and comparative measurements.

2.3 Absolute Read-Out

The signal output of an absolute coil.

2.4 Absolute Signal

The value of the amplitude of a signal without consideration of its relative phase, frequency, or waveform.

2.5 Absolute System

A system that comprises an absolute coil.

2.6 Acceptance Level

A test level above or below which test specimens are acceptable in contrast to rejection level.

2.7 Acceptance Limits

Test levels used in eddy current testing that establish the group into which a material under test belongs.

2.8 Acceptance Standard

A part used to establish the acceptance level with artificial discontinuities as specified in the applicable product standard.

2.9 Amplitude Distortion

Same as HARMONIC DISTORTION (2.68).

2.10 Amplitude Response

That property of a test system whereby the amplitude of the detected signal is measured without regard to phase [*see also* HARMONIC ANALYSIS (2.66) and PHASE ANALYSIS (2.107)].

2.11 Annular Coil Clearance

The mean radial distance between adjacent coil assembly and test part surface in eddy current encircling coil examination.

2.12 Annular Coils

See ENCIRCLING COILS (2.55).

2.13 Anomaly

A variation from normal material.

2.14 Artifact

An indication that is not associated with the actual condition of the object under test.

2.15 Artificial Discontinuity

Reference discontinuity such as holes, grooves, or notches that are introduced into a reference standard to provide accurately reproducible sensitivity levels for eddy current test equipment.

2.16 Attenuation

Decrease in signal magnitude in transmission from one point to another; may be expressed in decibels or as a scalar ratio of the input magnitude to the output magnitude.

2.17 Band Pass Filter

A wave filter having a single transmission band; neither of the cut-off frequencies being zero or infinity.

2.18 Band Width

The difference between the limiting frequencies of band pass filter.

2.19 Bobbin Coil

See ID COIL (2.73).

2.20 Bucking Coils

Same as DIFFERENTIAL COILS (*see* 2.41).

2.21 Calibration

The standardization of instruments, prior to use, to a known value.

2.22 Calibration Standard

(i) A physical reference used as a basis for comparison or calibration (ii) a concept that has been established by authority, custom, or agreement to serve as a model or rule in the measurement of quality or the establishment of a practice or procedure.

2.23 Circumferential Coils

See ENCIRCLING COILS (2.55).

2.24 Coil

One or more loops of a conducting material; a single coil may be an exciter and induce currents in the material or it may be a detector, or both, simultaneously.

2.25 Coil Clearance

See LIFT-OFF (2.83).

2.26 Coil Impedance

The ratio of coil voltage to coil current; it is affected by the material within the magnetic field generated by the coil and is sometimes used to measure eddy current response.

2.27 Coil Spacing

The axial distance between two encircling coils in a differential system.

2.28 Comparative Measurement

Measurements in which the unbalance in the system is measured using comparator coils in contrast to differential and absolute measurements. [See also COMPARATOR COIL (2.31)].

2.29 Comparative Read-Out

The signal output of comparator coils. (See also COMPARATOR COILS (2.31)).

2.30 Comparative System

Test system that uses coil assemblies and associated electronics to detect any electromagnetic condition that is not common to the test specimen and the standard. [See also COMPARATOR COILS (2.31)].

2.31 Comparator Coils

Two or more coils electrically connected in series opposition and arranged so that there is no mutual induction (coupling) between them such that any electromagnetic condition, that is, not common to the test specimen and the standard, will produce an unbalance in the system, and thereby yield an indication.

2.32 Conductivity

Inverse of resistivity; refers to the ability of a material to carry electrical current; unit is percent IACS.

2.33 Coupled

Two electric circuits are said to be coupled to each other when they have an impedance in common so that a current in one causes a voltage in the other.

2.34 Coupling Coefficient

The percentage of magnetic flux from a primary circuit that links a secondary circuit; the effectiveness of a coil in inducing eddy current in the test object.

2.35 Defect

An anomaly that limits or has the potential to limit the service performance of the test part.

2.36 Defect Resolution

The property of a test system that enables the separation of indications due to defects in a test specimen that are located in close proximity to each other.

2.37 Depth of Penetration

The depth at which the magnetic field strength or intensity of induced Eddy Current has

decreased to 37 percent of that at the surface of the material under test. The square of the depth of penetration is inversely proportional to : (1) the frequency of signal, (2) the conductivity of the material, and (3) the permeability of the material. Synonymous terms are standard depth of penetration and skin depth [See also SKIN EFFECT (2.136)].

2.38 Detector Coil

Senses field produced by excitation coil. [See also SENSING COIL (2.130)]

2.39 Diamagnetic Material

A material whose relative permeability is less than unity.

NOTE — The intrinsic induction, B_i , is oppositely directed to the applied magnetizing force, H .

2.40 Differential Amplifier

An amplifier whose output signal is proportional to the algebraic difference between two input signals.

2.41 Differential Coils

Two or more coils electrically connected in series opposition such that any electromagnetic condition that is not common to the areas of a specimen being electromagnetically tested will produce unbalance in the system and thereby yield an indication; the coils are physically adjacent in contrast to comparator coils that are not adjacent.

2.42 Differential Measurement

Measurements in which the unbalance in the system is measured using differential coils in contrast to absolute and comparative measurements. [See also DIFFERENTIAL COILS (2.41)].

2.43 Differential Read-Out

The signal output of differential coils. Observed on the suitable read-out mechanism of the test system. [See also DIFFERENTIAL COILS (2.41)].

2.44 Differential System

Testing system that uses coil assemblies and associated electronics to detect an electromagnetic condition that is not common to the areas of the specimen being tested [See also DIFFERENTIAL COILS (2.41)].

2.45 Differentiated Signal

An output signal, that is, proportional to the rate of change of the input signal.

2.46 Discontinuity

Lack of continuity, cohesion or homogeneity.

2.47 Eddy Current

An electrical current caused to flow in a conductor by the time or space variation, or both, of an applied magnetic field.

2.48 Eddy Current Testing

A non-destructive testing method in which eddy current flow is induced in a conductive test object. Changes in the flow caused by variation in the specimen are reflected into a nearby coil, coils or Hall effect device or other magnetic flux sensor for subsequent analysis by suitable instrumentation and techniques.

2.49 Edge Effect or End Effect

The disturbance of the magnetic field and eddy current due to the proximity of an abrupt change in specimen geometry (edge or end). This effect generally results in masking of indications due to discontinuities near edges.

2.50 Effective Depth of Penetration

The minimum depth beyond which a test system can no longer practicably detect a further increase in specimen thickness. (If the minimum thickness for the frequency used is not exceeded, or the specimen thickness is not rigidly controlled, the test may be influenced by the specimen thickness; depending on the criteria, this minimum thickness is three to seven times the skin depth.)

2.51 Effective Permeability

A hypothetical quantity that describes the magnetic permeability, that is, experienced under a given set of physical conditions such as a cylindrical test specimen in an encircling coil at a specific test frequency. This quantity may be different from the permeability of the particular metal being tested in that it takes into account such things as the geometry of the part, the relative position of the encircling coil, and the characteristics of the magnetic field.

2.52 Electrical Centre

The centre established by the electromagnetic field distribution within a test coil. A constant intensity signal, irrespective of the circumferential position of a discontinuity, is indicative of electrical centering. The electrical center may be different from the physical centre of the test coil.

2.53 Electric Field

A vector field of electric field strength or of electric flux density.

2.54 Electromagnetic Testing

A non-destructive test method for material, including magnetic materials, that used electromagnetic conductive energy having frequencies less than those of visible light to yield information regarding the quantity and characteristics of the tested material. Eddy current testing is one of such methods.

2.55 Encircling Coils

In eddy current testing coil(s) or coil assembly that surround(s) the part to be tested. Coils of this type are also referred to as annular, circumferential, or feedthrough coils.

2.56 Feedthrough Coils

See ENCIRCLING COILS (2.55).

2.57 Ferromagnetic Material

A material that, in general, exhibits the phenomena of magnetic hysteresis and saturation, and whose permeability is dependent on the magnetizing force.

2.58 Field Coil

The coil generating the magnetic field that produces eddy currents in the part being tested.

2.59 Fill Factor

For encircling coil method testing, the ratio of the cross-sectional area of the test specimen to the effective cross-sectional core area of the primary encircling coil (outside diameter of coil form, not inside diameter which is adjacent to specimen). For internal probe method testing, the ratio of the effective cross-sectional area of the primary internal probe coil to the cross-sectional area of the tube interior.

2.60 Fill-Factor Effect

The effect of fill factor on coupling between coil and test object.

2.61 Filter

A network that passes electromagnetic wave energy over a prescribed range of frequencies and attenuates energy at all other frequencies.

2.62 Flaw

See DEFECT (2.35).

2.63 Flaw Inversion

A method for measuring some dimension(s) of a flaw by the application of a mathematical algorithm to the flaw signal.

2.64 Gate

The time duration for which the signal is observed.

2.65 Hall Detector

A semiconductor element that produces an output electromotive force proportional to the product of the magnetic field intensity and a biasing current.

2.66 Harmonic Analysis

An analytical technique whereby the amplitude and phase, or both of the frequency components of complex periodic signal is determined.

2.67 Harmonic Analyzer

A mechanical device for measuring the amplitude and phase of the various harmonic components of a periodic function from its graph.

2.68 Harmonic Distortion

Non-linear distortion characterized by the appearance in the output of harmonics other than the fundamental component when the input wave is sinusoidal.

2.69 Hertz

The unit of frequency; one hertz is one cycle per second.

2.70 Horseshoe Coil

A probe coil in which the ferrite core of the coil is horseshoe shaped. Also called U-shape coil.

2.71 Hysteresis Loss

The energy loss in magnetic material which results from an alternating magnetic field as the elementary magnets within the material seek to align themselves with the reversing magnetic field.

2.72 IACS

The International Annealed Copper Standard : an electrical conductivity measurement system in which the electrical conductivity of annealed, unalloyed copper is arbitrarily rated at 100 percent at a reference temperature of 20°C, and the conductivities of other materials are expressed as percentages of this standard.

$$\text{Percent, IACS} = \frac{172.41}{\text{Resistivity of material in micro ohm-centimetres}}$$

2.73 ID Coil

A coil or coil assembly used for eddy current testing by insertion into the test pieces in the case of an inside probe for tubing. Coils of this type are also referred to as inside coils, inserted coils, or bobbin coils.

2.74 Impedance

The total opposition that a circuit presents to the flow of an alternating current; specifically, the complex quotient of voltage divided by current.

2.75 Impedance Analysis

An analytical method that consists of correlating changes in the amplitude, phase, or quadrature components, or all of these of a complex test signal voltage to the electromagnetic conditions within the test specimen.

2.76 Impedance Plane Diagram

A graphical representation of the locus of points, indicating the variation in the impedance of a test coil as a function of basic test parameters.

2.77 Incremental Permeability

The ratio of the change in magnetic induction to the corresponding change in magnetizing force when the mean induction differs from zero.

2.78 Inductor

A device consisting of one or more associated windings with or without a magnetic core, for introducing inductance into an electric circuit or material.

2.79 Initial Permeability

The slope of the induction curve at zero magnetizing force as the test specimen is being

removed from a demagnetized condition. (Slope at origin of B—H curve before hysteresis is observed.).

2.80 Inserted Coil

See ID COIL (2.73).

2.81 Inside Coil

See ID COIL (2.73).

2.82 Leakage Flux

Magnetic flux of the coil that does not link with the test object, the magnetic flux that leaves a saturated or nearly saturated specimen at a discontinuity.

2.83 Lift-Off

Distance between the probe coil and the test object.

2.84 Lift-Off Effect

The effect observed in an eddy current test system output due to a change in magnetic coupling between a test specimen and a probe coil whenever the distance between them is varied.

2.85 Magnetic Field

The space around a magnet or any conductor carrying current, within which ferromagnetic materials are altered is called a magnetic field.

2.86 Magnetic Induction

Generation of magnetic field in a conductivity medium due to rate of change. Of magnetic flux in and adjacent conductivity medium.

2.87 Magnetic History

Magnetic condition of a ferromagnetic part based on previous exposures to magnetic fields.

2.88 Magnetic Saturation

That degree of magnetization where a further increase in magnetizing force produces no significant increase in magnetic flux density (permeability) in a specimen.

2.89 Magnitude

The absolute value of complex quantity (number) without reference to the phase of the quantity.

2.90 Model, Analytical

A representation of a process or phenomenon by a set of solvable equations.

2.91 Modulation Analysis

An analytical (instrumentation) method used in eddy current testing that separates responses due to various factors influencing the total magnetic field by separating and interpreting, individually, frequencies or frequency bands in the modulation envelope of the (carrier frequency) signal.

2.92 Multifrequency

Two or more frequencies applied sequentially or simultaneously (as in the form of a pulse).

2.93 Multifrequency Technique

Utilization of the response of a test specimen to more than one frequency, usually to separate effects that would be indistinguishable at a single frequency.

2.94 Multiparameter

Many parameters of a test system which affect the response; these parameters can often be distinguished with a multifrequency technique.

2.95 Multivariable

See MULTIPARAMETER (2.94).

2.96 Mutual Inductance

The common property of two electrical circuits whereby an electromotive force is induced in one circuit by a change of voltage in other circuit.

2.97 Noise

Any non-relevant signal that tends to interfere with the normal reception or processing of desired low signal. It should be noted that such noise signals may be generated by inhomogeneities in the inspected part that are not detrimental to the end use of the part.

2.98 Non-ferromagnetic Material

A material that is not magnetizable and hence, essentially not affected by magnetic fields. This would include paramagnetic and diamagnetic materials.

2.99 Normalized Impedance Diagram

An impedance curve from which the effect of frequency on the probe in air have been removed. Usually the plotted data are, the measured reactance divided by the reactance of the coil in air *versus* the measured resistance less the resistance in air divided by the coil reactance in air.

2.100 Normal Permeability

The ratio of the induction (when cyclically made to change symmetrically about zero) to the corresponding change in magnetizing force.

2.101 Null (Balance)

To adjust a bridge circuit so that the test sample and reference arms produce equal and opposite currents through the detector.

2.102 Null Signal

A fixed component of the test coil signal that is subtracted from the output signal only leaving that part of the signal that varies with test object condition; it reduces dynamic range requirements.

2.103 Optimum Frequency

The test frequency which provides the largest signal-to-noise ratio obtainable for the detection of an individual material property. Each property of a given material may have its own optimum frequency.

2.104 Pancake Coil

A probe coil whose axis is normal to the surface of the test material and whose length is not longer than the radius.

2.105 Paramagnetic Material

A material that has a relative permeability slightly greater than unity and that is practically independent of the magnetizing force.

2.106 Permeability

A measure of the ability of the material to support magnetic field. Permeability measurements are usually made in terms of relative permeability with free space assigned to the value of unity.

A general term used to express various relationships between magnetic induction and magnetizing force. These relationships are either: (1) absolute permeability, that in general is the quotient of a change in magnetic induction divided by the corresponding change in magnetizing force, or (2) specific (relative) permeability to the magnetic constant; relative permeability is a mere number that is the same in all unit systems; the value and dimension of absolute permeability depend on the system of units employed. In anisotropic media, permeability becomes a matrix.

2.107 Phase Analysis

An analytical technique that discriminates between variables in a part undergoing eddy current testing by the different phase angle changes that these conditions produce in the test signal. [See also PHASE DETECTION (2.109).]

2.108 Phase Angle

The angular equivalent of the time displacement between corresponding points on two sine waves of the same frequency.

2.109 Phase Detection

The derivation of a signal whose amplitude is a function of the phase angle between two alternating currents, one of which is used as a reference.

2.110 Phase-Sensitive System

A system whose output signal is dependent on the phase relationship between the voltage returned from a pick up or sensing coil and a reference voltage.

2.111 Phase Shift

A change in the phase relationship between two alternating quantities of the same frequency.

2.112 Probe Coil

In eddy current testing a small coil or coil assembly that is placed on or near the surface of the test objects.

2.113 Probe Coil Clearance

The perpendicular distance between adjacent surfaces of the probe and test part; also called lift-off.

2.114 Pulse Method

Multifrequency technique in which a broadband excitation such as an impulse is used; either the frequency components are extracted and analyzed or the interpretation is based directly on characteristics of the time domain waveform.

2.115 'Q' of a Coil

Ratio of reactance to resistance measured at the operating frequency.

2.116 Quadrature

The relation between two periodic functions when phase difference between them is one-fourth of a period.

2.117 Read-Out Mechanism

The display means, used to indicate the signal corresponding to the eddy current test signal of the test coil. The display means can be in variety of forms such as analogue meter, digital meter, cathode ray tube (CRT) or strip chart recorder.

2.118 Recovery Time

The time required for a test system to return to its original state after it has received a signal.

2.119 Reference

The section of the coil assembly that excites or detects, or both, the electromagnetic field in the reference standard in a comparative test system.

2.120 Reference Standard

A reference used as basis for comparison or calibration. In tubing (or bar) inspection, a tube (or bar) with artificial discontinuities used for establishing the test sensitivity setting and for periodically checking and adjusting sensitivity setting as required. [*See also* STANDARD DEPTH OF PENETRATION (2.139).]

2.121 Reflection Probe

A coil system which utilizes both an excitation and a detection or sensing coil on the same side of the sample.

2.122 Rejection Level

The value established for a test signal above or below which test specimens are rejectable or otherwise distinguished from remaining specimens. Note that this is different from the rejection level as defined for ultrasonic and other test systems.

2.123 Relative Permeability

The ratio of the permeability of the material to the permeability of vacuum. *See* PERMEABILITY (2.106).

2.124 Response Function

The ratio of the response to excitation, both expressed as functions of the complex frequency.

2.125 Search Coil

A detection coil which is usually smaller than the excitation coil.

2.126 Secondary Magnetic Flux

Magnetic flux due to induced flow of eddy currents.

2.127 Segment Test Head

Test coil that tests only a limited portion of the circumference of the tube; usually used for eddy current examination of the weld zone, and the portion adjacent to it, in welded tubes.

2.128 Selectivity

The characteristic of a test system that is a measure of the extent to which an instrument is capable of differentiating between the desired signal and disturbances of the frequencies or phases.

2.129 Self-Inductance

The property of an electric circuit where an electromotive force (emf) is induced in the circuit by a change in current in the circuit. The emf induced is self-inductance times the rate of change of current.

2.130 Sensing Coil

A coil that detects changes in the flow of eddy currents induced by an excitation coil; sensing and excitation coils may be one and the same.

2.131 Shielding

A conducting or magnetic material (or a combination of both) placed so as to decrease susceptibility to electromagnetic interference and to increase resolution.

2.132 Signal

Response containing relevant information.

2.133 Signal Gradient

Same as DIFFERENTIAL READ-OUT (*see* 2.43).

2.134 Signal-to-Noise Ratio

The ratio of values of signal (response containing relevant information) to that of noise (response containing non-relevant information).

2.135 Skin Depth

See DEPTH OF PENETRATION (2.37).

2.136 Skin Effect

The phenomena wherein the depth of penetration of electrical currents into a conductor decreases as the frequency of the current is increased. At very high frequencies, the current flow is restricted to an extremely thin outer layer of the conductor. [*See also* DEPTH OF PENETRATION (2.37).]

2.137 Speed Effect

The phenomenon in eddy current testing of which the evidence is a change in the signal voltage resulting from a change in the relative motion between the specimen and a test coil assembly.

2.138 Squid

Superconducting Quantum Interference Device; a sensitive detector of magnetic fields utilizing a quantum effect.

2.139 Standard Depth of Penetration

See DEPTH OF PENETRATION (2.37).

2.140 Tape Head Probe

The head of a tape recorder used as an eddy current coil; a type of horseshoe coil.

2.141 Test Coil

The section of the coil assembly that excites and/or detects the magnetic field in the material under test.

2.142 Test Frequency

The number of complete cycles per unit time of the alternating current applied to the primary test coil.

2.143 Test Quantity Level

See REJECTION LEVEL (2.122).

2.144 Three-Way Sort

An electromagnetic sort based on a signal response from the material under test above or below two levels established by three or more calibration standards.

2.145 Threshold Level

The setting of an instrument that causes it to register only those changes in response greater than a specified magnitude.

2.146 Through Transmission

A method of testing in which the excitation coil is placed on one surface of the test object and

the transmitted signal is detected by a sensing coil on the opposite surface.

2.147 Time Sharing Mode

The term relates to multifrequency eddy current test system where each of test frequency is applied to test coil for a fixed time duration one after another.

2.148 Transducer

A device by means of which energy can flow from one or more transmission systems or media to one or more other transmission systems or media; in eddy current testing, usually refers to the 'test coil'.

2.149 Two-Way Sort

An electromagnetic sort based on a signal response from the material under test above or below a level established by two or more calibration standards.

2.150 U-Shaped Coil

See HORSESHOE COILS (2.70).

2.151 Wobble

An effect that produces variations in an output signal of the test system and arises from variations in coil spacing (operational fill factor or coupling factor) due to lateral motion of the test specimen in passing through an encircling coil.

2.152 Yoke

A magnet that induces a magnetic field in the area of a part that lies between its poles; yokes may be permanent magnets or either AC or DC electromagnets.

Standard Mark

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Revision of Indian Standards

Indian Standards are reviewed periodically and revised, when necessary and amendments, if any, are issued from time to time. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition. Comments on this Indian Standard may be sent to BIS giving the following reference :

Doc : No. MTD 21 (3534)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices :

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg
NEW DELHI 110002

Telephone
{ 331 01 31
{ 331 13 75

Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola
CALCUTTA 700054

37 86 62

Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036

2 18 43

Southern : C.I.T. Campus, IV Cross Road, MADRAS 600113

41 29 16

Western : Manakalaya, E9 MIDC, Marol, Andheri (East)
BOMBAY 400093

6 32 92 95

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR.
COIMBATORE, FARIDABAD, GHAZIABAD, GUWAHATI.
HYDERABAD. JAIPUR. KANPUR. PATNA. THIRUVANAN THAPURAM